(12) UK Patent Application (19) GB (11) 2 281 980 (13) A

(43) Date of A Publication 22.03.1995

(21) Application No 9413941.7

(22) Date of Filing 11.07.1994

(30) Priority Data
(31) 05235351 (32) 26.08.1993 (33) JP

(51) INT CL[6]
G03B 27/04 27/60

(52) UK CL (Edition N)
G2X XB28 X101 X103

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(58) Field of Search
UK CL (Edition M) G2X XB28
INT CL[5] G03B

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(54) Printing frame

(57) A printing frame has an enclosable space (S) to receive masks (F) on either side of a substrate (P) with photosensitive layers on both sides. Flexible films (4a, 4b) on either side of the mask can be inflated by pump (7) to establish tight fitting between the mask (F) and the substrate (P) by elastic expansion thereof. Also, a pressure reducing device (9) is provided for creating a vacuum in the enclosed space (S) for further establishing tight fitting between the mask (F) and the substrate (P). An exposure arrangement (20, 20b) contact exposes the photosensitive layers to the masks (F) tightly fitted on the substrate (P).

FIG.1

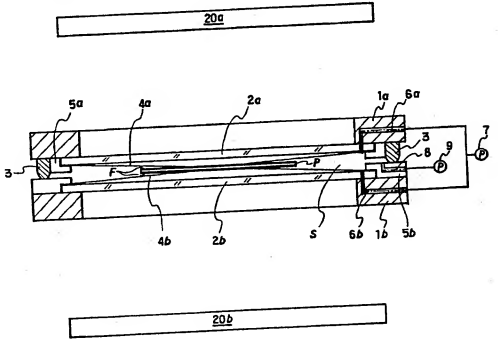

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FIG.1

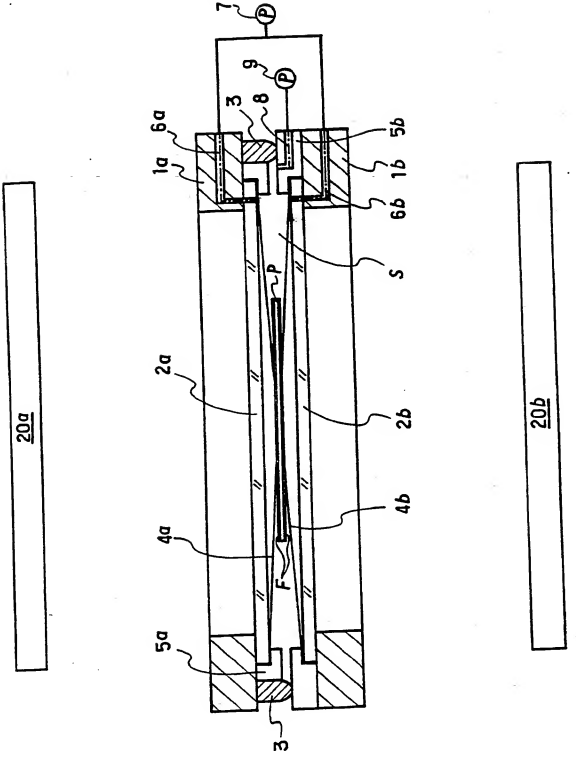
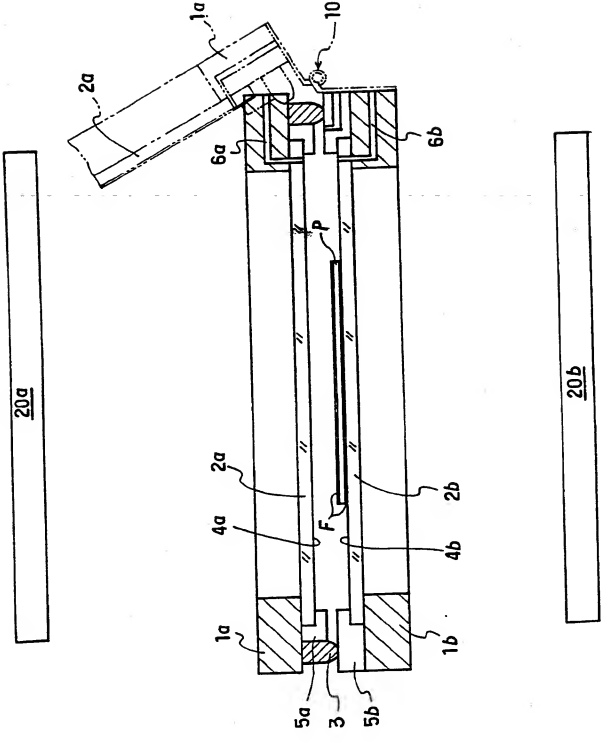


FIG.2



ALIGNER

BACKGROUND OF THE INVENTION

Field of the Invention

The present invention relates to an aligner for printing a circuit pattern and so forth on a film mask or so forth on a printed circuit board or the like.

Description of the Related Art

In fabrication of a printed circuit board and so forth, a photolithographic method has been recently employed for printing a pattern employing an original containing a circuit pattern to be formed and projecting a light for exposure for printing the pattern.

Since high precision is required in fabrication of an integrated circuit (IC), a glass plate is used as a media for forming the original. However, in the case of the printed circuit boards or so forth, which do not require relatively low precision, film masks are typically employed.

However, when the film mast is employed, if fitting between the film mask and the printed circuit board is insufficient, penetration of the light can be caused to fluctuate the width of the pattern. Therefore, it is extremely important to firmly fitting the film mask and the printed circuit board.

In the prior art, in order to firmly fit the film mask and the printed circuit board, after

mechanically fitting the film mask and the printed circuit board, drawing is performed to remove air between the film mask and the printed circuit board to establish firm fitting between the film mask and the printed circuit board.

However, in the conventional aligner, the air between the film mask and the printed circuit board cannot be removed smoothly and possibly takes 60 to 120 seconds for completely removing the air. On the other hand, in order to shorten the period required for removal of the air, it becomes necessary to scrub the film mask by means of a special tool for removing the air between the film mask and the printed circuit board. This process is cumbersome.

SUMMARY OF THE INVENTION

It is an object of the present invention to solve the problem in the prior art as set forth above.

According to one aspect of the invention, an aligner comprises:

an enclosable space receiving therein a mask and a substrate;

tight fitting means formed of a flexible material for establishing tight fitting between the mask and the substrate by elastic expansion thereof;

pressure reducing means for reducing pressure in the enclosed space for further establishing tight fitting between the mask and the substrate; and

exposure means for performing exposure of the mask tightly fitted on the substrate by means of the tight fitting means and the pressure reducing means.

Preferably, the tight fitting means comprises a flexible film for causing expansion by introducing a fluid therein and depressing the mask onto the substrate by expansion of the flexible film. In the further preferred construction, the tight fitting means may comprise an exposure wavelength transparent plate and a flexible film having transparency at the exposure wavelength and fixed to the plate, for causing expansion by introducing a fluid between the plate and the flexible film and depressing the mask onto the substrate by expansion of the flexible film.

The tight fitting means may expand the flexible film gradually from the center portion thereof to propagate the contacting area in radially outwardly. In this case, it is possible that the tight fitting means expands the flexible film gradually from the center portion thereof to depress the center portion of the mask onto the substrate.

According to another aspect of the invention, an aligner comprises:

an enclosable space receiving therein a mask and a substrate;

an exposure wavelength transparent plate forming a part of the enclosable space;

tight fitting means formed of a flexible film having a transparency at the exposure wavelength and fixed to the circumference of the exposure wavelength transparent plate for establishing tight fitting between the mask and the substrate by elastic expansion thereof;

fluid introducing means for introducing a fluid between the exposure wavelength transparent plate and the flexible film for gradually expanding the flexible film for depressing the central portion of the mask to establish tight fitting between the mask and the substrate at least at the central portion;

pressure reducing means for reducing pressure in the enclosed space for further establishing tight fitting between the mask and the substrate firmly fitted to each other at the central portion; and

exposure means for irradiating an exposure light onto the mask and the substrate through the exposure wavelength transparent plate for exposure.

BRIEF DESCRIPTION OF THE DRAWINGS

The present invention will be understood more fully from the detailed description given herebelow and from the accompanying drawings of the preferred embodiment of the invention, which, however, should not be taken to be limitative to the invention, but are for explanation and understanding only.

In the drawings:

Fig. 1 is a sectional side view of one embodiment

of an aligner according to the present invention; and

Fig. 2 is a sectional side elevation of one embodiment of the aligner according to the invention, illustrated in a condition of use.

DESCRIPTION OF THE PREFERRED EMBODIMENT

A preferred embodiment of an aligner according to the present invention will be discussed hereinafter in detail with reference to the accompanying drawings. In the following description, numerous specific details are set forth in order to provide a thorough understanding of the present invention. It will be obvious, however, to those skilled in the art that the present invention may be practiced without these specific details. In other instances, well-known structures are not shown in detail in order not to unnecessary obscure the present invention.

In Fig. 1, an enclosed space **S** is defined by a pair of printing frames **1a** and **1b** arranged in vertical symmetric positions, glasses **2a** and **2b** mounted on respective printing frames **1a** and **1b** and having transparency for exposure wavelength light, and a packing **3** extending in the periphery of the printing frames and disposed therebetween.

A printed circuit board **P**, on which film masks **F** are fitted at both of the surface side and the back side is disposed within the enclosed space **S**. The printed circuit board **P** is exposed by a predetermined

wavelength of light discharged from exposure light sources **20a** and **20b** respectively arranged at above the glass **2a** and below the glass **2b**.

On respective glasses **2a** and **2b**, pressurizing films **4a** and **4b** are filled. The pressurizing films **4a** and **4b** are firmly fixed to respectively corresponding glasses **2a** and **2b** at the circumferences thereof by means of fixtures **5a** and **5b**. The fixtures **5a** and **5b** also serves for rigidly fixing the glasses **2a** and **2b** to respectively corresponding printing frames **1a** and **1b**.

The printing frames **1a** and **1b** are provided air induction openings **6a** and **6b**. The air induction openings **6a** and **6b** extend through the glasses **2a** and **2b** to open to a clearance between the glasses and the pressurizing films **4a** and **4b**.

The air induction openings **6a** and **6b** are connected to an air pump **7** so that a pressurized air is introduced into the clearances between the glasses **2a** and **2b** and the pressurizing films **4a** and **4b**. It should be noted that any fluid having transparency for the exposure wavelength light may be employed in place of the air.

The pressurizing film **4a** and **4b** are expanded by the pressurized air introduced into the clearances defined between the pressurizing film and the glass plates **2a** and **2b** to bulge the center portion to form substantially hemispherical configuration, as illustrated.

While the pressurizing film **4a** and **4b** can be expanded to form the hemispheric configuration by fastening the periphery, it should be possible to preliminarily form the pressurizing films **4a** and **4b** to form desired hemispheric configuration as increasing the pressure.

Any material which has flexibility and satisfactory transparency at the exposure wavelength light.

The pressurizing films **4a** and **4b** in the expanded contact with the film masks **F** at both of the surface side and the back side to elastically depress the corresponding film masks toward the printed circuit board **P**. Elastic depression of the film mask **F** by the bulged center portion of the pressurizing films **4a** and **4b** forces the air within the clearance between the film masks **F** and the printed circuit board **P** to establish firm fitting of the film masks onto the surfaces of the printed circuit board.

It should be noted that it will be sufficient to depress the center portions of the film masks **F** by the pressurizing films **4a** and **4b** in order to remove the air between the film masks and the printed circuit board. However, it is also possible to design the pressurizing films **4a** and **4b** to exert elastic depression force on overall surfaces of the film masks **F**.

On the other hand, it is possible that the

pressurizing film **4a** and **4b** are not expanded at the initial stage and gradually expanded to gradually contact to the film mask **F** so that firm fitting between the film mask **F** and the printed circuit board **P** is initially established at the center portion and then the contacting area is expanded toward radially outside. With this manner, the air between the film mask **F** and the printed circuit board **P** can be effectively removed.

The fixture **5b** is formed with an air discharge opening **8**. The air discharge opening **8** opens to the enclosed space **S** inside of the packing **3**. A discharge pump **9** is connected to the air discharge opening **8** so that the air in the enclosed space **S** is drawn by the discharge pump **9**. Therefore, vacuum is introduced into the enclosed chamber **S**.

By introduction of vacuum in the enclosed chamber **S**, the air between the film mask **F** which is depressed by the pressurizing films **4a** and **4b** and the printed circuit board **P** can be further removed so that the film mask **F** and the printed circuit board **P** can be substantially completely fitted.

It should be noted that, as shown in **Fig. 2**, an opening and closing mechanism **10** is provided at one side portion of the printing frames **1a** and **1b** so that the printed frame **1a** can be selectively placed in open position and closed position.

Next, discussion will be given for use of the

preferred embodiment of the aligner constructed as set forth above.

As shown in **Fig. 2.** at the initial state, the pressurized air is not introduced into the clearance between the pressurizing films **4a** and **4b** and the glasses **2a** and **2b** so that the pressurizing films are loosely fitted on respectively corresponding glasses. At this condition, the printing frame **1a** is opened. Then, the printed circuit board **P**, on which the film masks **F** are fitted, is placed on the pressurizing film **4b** which is in the state loosely fitted on the glass **2b**. Then, the printing frame **1a** is closed and fastened to enclose the enclosed space **S**. Subsequently, the air pump **7** is driven to supply the pressurized air into the clearances between respective pressurizing films **4a** and **4b** and the glasses **2a** and **2b** to expand the pressurizing films **4a** and **4b**.

The pressurizing films **4a** and **4b** gradually expand to initially contact with the film masks **F** at the center portion, and subsequently expand the contacting area in radially outward. By the elastic depression force exerted on the film masks **F** by the expanded pressurizing films **4a** and **4b**. By this, firm fitting between the film masks **F** and the corresponding surfaces of the printed circuit board **P** is established initially at the center portion and then propagate radially outward with removing the air therebetween. In this manner, the air between the film mask **F** and the printed circuit board

P can be efficiently removed without residing.

This condition is shown in Fig. 2.

Next, the discharge pump 9 is driven to ventilate the air in the enclosed space S. By this the air around the firmly fitted central portion between the film masks F and the printed circuit board P elastic depression force by the pressurizing films 4a and 4b, can be efficiently removed to establish completely fitted state between the film masks F and the printed circuit board P.

At this condition, the exposure lights are irradiated from the exposure light sources 20a and 20b to print the pattern of the film masks F on the printed circuit board P.

The printed circuit board P after completion of exposure is fed to a next step to be processed in photoetching and so forth to form the circuit.

As set forth above, in the foregoing embodiment, the air between the film mask F and the printed circuit board P is initially removed by elastic depression by the pressurizing films 4a and 4b at contacted at the central portion. The air between the film mask F and the printed circuit board P is then further removed by introduction of vacuum in the enclosed space S by the operation of the discharge pump 9. Therefore, with the shown embodiment, firm fitting between the film masks and the printed circuit board can

be established easily and efficiently to permit high precision exposure.

As set forth above, since the aligner according to the present invention has an enclosable space to receive the film mask and the printed circuit board, a tight fitting means made of a flexible material and serving for tightly fitting the film mask onto the printed circuit board by expansion thereof, means for reducing the pressure in the enclosable space, and means for performing exposure for the film mask firmly fitted onto the printed circuit board by the tight fitting means and the pressure reducing means, firm fitting between the film masks and the printed circuit board can be established easily and efficiently to permit high precision exposure.

Although the invention has been illustrated and described with respect to exemplary embodiment thereof, it should be understood by those skilled in the art that the foregoing and various other changes, omissions and additions may be made therein and thereto, without departing from the spirit and scope of the present invention. Therefore, the present invention should not be understood as limited to the specific embodiment set out above but to include all possible embodiments which can be embodies within a scope encompassed and equivalents thereof with respect to the feature set out in the appended claims.

WHAT IS CLAIMED IS:

1. An aligner comprising:

an enclosable space receiving therein a mask and a substrate;

tight fitting means formed of a flexible material for establishing tight fitting between said mask and said substrate by elastic expansion thereof;

pressure reducing means for reducing pressure in said enclosed space for further establishing tight fitting between said mask and said substrate; and

exposure means for performing exposure of said mask tightly fitted on said substrate by means of said tight fitting means and said pressure reducing means.

2. An aligner as set forth in claim 1, wherein said tight fitting means comprises a flexible film for causing expansion by introducing a fluid therein and depressing said mask onto said substrate by expansion of said flexible film.

3. An aligner as set forth in claim 1, wherein tight fitting means comprises an exposure wavelength transparent plate and a flexible film having transparency at said exposure wavelength and fixed to said plate, for causing expansion by introducing a fluid between said plate and said flexible film and depressing said mask onto said substrate by expansion of said flexible film.

4. An aligner as set forth in claim 3, wherein said tight fitting means expands said flexible film gradually from the center portion thereof to propagate the contacting area in radially outwardly.

5. An aligner as set forth in claim 3, wherein said tight fitting means expands said flexible film gradually from the center portion thereof to depress the center portion of said mask onto said substrate.

6. An aligner comprising:

an enclosable space receiving therein a mask and a substrate;

an exposure wavelength transparent plate forming a part of said enclosable space;

tight fitting means formed of a flexible film having a transparency at the exposure wavelength and fixed to the circumference of said exposure wavelength transparent plate for establishing tight fitting between said mask and said substrate by elastic expansion thereof;

fluid introducing means for introducing a fluid between said exposure wavelength transparent plate and said flexible film for gradually expanding said flexible film for depressing the central portion of said mask to establish tight fitting between said mask and said substrate at least at the central portion;

pressure reducing means for reducing pressure in said enclosed space for further establishing tight fitting between said mask and said substrate firmly fitted to each other at the central portion; and

exposure means for irradiating an exposure light onto said mask and said substrate through said exposure wavelength transparent plate for exposure.

7. An exposure apparatus for photographic printed circuit board production comprising a space for receiving a photosensitive board on which a film mask is fitted, inflatable means and inflating means for inflating the inflatable means, wherein, the inflating means operates to inflate the inflatable means during which operation the inflatable means is caused to press the film mask against the photosensitive board to assist removal of air from between the film mask and the photosensitive board.

8. An exposure apparatus according to claim 7, wherein, during inflation, the inflatable means initially makes contact with a central portion of the film mask and thereafter contacts a radially expanding area of the film mask.

9. An exposure apparatus according to claim 7 or 8, wherein a further inflatable means is provided for operating against a further film mask on the opposite face of the photosensitive board.

10. A method of assisting the removal of air from between a photosensitive board and a film mask comprising the steps of:

locating a photosensitive board, on which a film mask is

fitted, for exposure; and

inflating an inflatable member to thereby cause the film mask to be pressed against the photosensitive board.

11. A method according to claim 10, wherein the inflatable member is inflated to initially make contact with a central portion of the film mask and thereafter contact a radially expanding area thereof.

12. A method comprising performing a method according to claim 10 or 11 simultaneously in respect of film masks positioned on respective opposite faces of a photosensitive board.

13. An exposure apparatus substantially as hereinbefore described with reference to the accompanying drawings.

14. A method of assisting the removal of air from between a photosensitive board and a film mask substantially as hereinbefore described.